

Advanced Fuel Cycle Initiative



Technical Monthly - March 2003

Technical Integration

Systems Analysis

- **[All]** To support the FY03 Report to Congress, a qualitative comparison matrix of reactor and advanced fuel cycle options was created. For the Generation-IV reactor concepts safety, economics, and fuel utilization parameters were compared. Once-through, single and double tier transmutation, and thorium fuel cycle options were considered. Key repository performance impacts (e.g., volume, heat load, and dose) were rated. In addition, the fuel cycle and reactor facility requirements, life cycle costs, and repository savings were compared. Explanatory notes were provided for the specific attractiveness ratings. Similar materials were provided for comparison of spent fuel treatment technologies.
- **[SNL]** Initiated investigations for processes on protecting Applied Technology information from unlimited distribution.
- **[SNL]** Attended AFCI Separation Working Group meeting at Savannah River Site
- **[SNL]** Compiled Quarterly Report for 1st Quarter of FY03.
- **[SNL]** Attended National Technical Director Program Plan Revision Meeting in Germantown, MD.

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Transmutation Studies and Integrated Fuel Cycle Modeling

- **[ANL, INEEL, LANL, PNNL]** A meeting of the Transmutation Criteria sub-group was held at ANL on March 24, 2003. Key questions requiring transmutation approach were discussed:
 - should long-lived fission products be transmuted or converted to superior waste forms?
 - is Pu+Np only to be burned in Series 1 reactors?
 - is uranium disposable as Class C waste?
 - is inert matrix fuel development required?
 - what fraction of Cs/Sr needs to be extracted from nuclear waste?
 - what fraction of minor actinides should be extracted from nuclear waste?
 - is zero fission gas release during fuel processing achievable and reasonable?Participants were tasked to summarize and document the relevant issues and recommend specific transmutation criteria.
- **[ANL]** The behavior of Am-241 targets in a thermal spectrum was investigated in response to a DOE-NE inquiry. It was found that at typical PWR flux value, the Am-241 mass, by virtue of its high capture cross section, is reduced by about two orders of magnitude in about 10 years. The trend of the combined mass for Am-241, Pu-241, Np-237, and Cm-245 is quite similar indicating a significant reduction of key daughter products (e.g., Np-237) that impact Yucca Mountain performance. However, it should be noted that significant increases in PWR uranium enrichment are required to meet typical operational cycle length with such targets.
- **[LANL]** Progress was made on the benchmark of

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the CEA COSI and NFCSim codes:

- completed the simulation of the benchmark scenario.
- transmitted the results to CEA for comparison.

- [LANL] Two conference abstracts were submitted to the Advances in Nuclear Fuel Management III Conference, Hilton Head Island, South Carolina, October 5-8, 2003:

- E. A. Schneider and M. R. James, "The ORIGENInterface Capability of NFCSim."
- C. G. Bathke, S. DeMuth, M. R. James, and E. A. Schneider, "NFCSim: A Dynamic Simulation Model of the Nuclear Economy."

- [ANL] Work continued on the design of a heterogeneous MOX assembly (multiple enrichment zones) for Series 1 transmutation. A procedure was developed to perform efficiently scoping calculations of a mixed MOX/UO₂ lattice to optimize the fuel pin loadings.

- [ANL] Detailed isotopic vectors (actinides, fission products) were prepared for spent MOX assemblies. These data will be used to evaluate repository impact analyses of recycling scenarios with separated Pu (two recycles in an ALWR) and Pu+Np (one recycle).

- [ANL] WIMS8/ORIGEN2 analyses have been performed for two spent BWR fuel pins, which will be processed in the UREX+ demonstration later this year.

- [LANL] The criticality engine/ORIGEN2 burnup calculation driver was integrated into NFCSim, providing the capability to generate material balances for an arbitrary transient tier-1 scenario "on the fly".

- [LANL] Material balance results from the Tier-1 criticality engine were successfully benchmarked against OECD data.

- [LANL] A top-level reprocessing model was prepared for determination of repository waste composition. The preliminary species and separation

factors used in the model were selected from (1) results presented at the recent AFCI semi-annual meeting in Albuquerque, and (2) discussions with the AFCI Separations Team members

- [ANL] The repository impact of using graphite moderated gas cooled reactors is being estimated and compared with repository conditions resulting from using spent PWR fuel:

- The higher fuel burnup, up to 80,000 MWd/MT, of the gas-cooled graphite moderated reactor generates slightly less (10-20%) heat-generating actinides per MW/d than a PWR.

- The low heavy metal content of the gas reactor assemblies results in a high waste volume, but the specific decay heat generation is proportionally reduced. Because disposal in the repository is typically limited by decay heat, not volume, the impact on repository loading may not be important.

- Even in graphite, the major source of carbon-14 activation is nitrogen impurities. However, the contribution of carbon-14 to the repository dose rate is quite small.

Thus, preliminary results indicate no significant adverse or beneficial effect on the repository associated with the use of graphite moderated gas cooled reactors as compared to the once-through fuel cycle in PWRs.

- [ANL, LANL] The preliminary report for Phase 1, with the description of four proposed safeguards approaches, has been issued and distributed. A supporting document on assessment of NDA methods has also been completed by LANL.

- [ANL, LANL] A coordination meeting was held at ANL/W on March 25-26 with NA-241 participation; a tour of the FCF and HFEF facilities was included. The Phase 1 report was reviewed in detail; agreement was reached on the remaining tasks, schedule, and responsibilities. For Phase 2, a list of technology development items that will need to be completed to demonstrate the safeguards technology options was assembled.

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- [LANL] As part of the Non-proliferation and Safeguards task, cross sections for Pu and U were computed to enable bare critical mass computations with arbitrary compositions.

Repository Impacts

- [LLNL] Support for the draft Memorandum of Agreement between AFCI and DOE-RW continued with LLNL and OCRWM contractor staff (from Booz-Allen-Hamilton) iterating proposed workscope. LLNL proposed a series of activities beginning with basic information exchange and progressing through increasingly complex analyses to provide the type of products needed for future AFCI decisions.
- [LLNL] Repository impact workscope is being revised consistent with FY-03 funding at each participant.
- [LLNL] FY-03 Funds arrived at the end of the month. This allows work on Engineered Product Storage Forms to resume.

***For more information on Systems Analysis
contact Ralph Bennett: (208) 526-7708***

Separations

Integration

- A three-day AFCI Separations Working Group meeting was conducted at the Savannah River Research Campus on March 18-20 to focus upon detailed discussion and planning for deliverables from the various team leads. It proved very beneficial to share ideas with full team participation concerning separations technology and flowsheet descriptions, engineered product storage forms, and deployment strategy and scenarios. An added half-day was spent revising work packages and budget planning.

Advanced Aqueous Separations

- [ANL] *AMUSE 2.2 Development*. The report-generation module in AMUSE was rewritten in Microsoft Visual Basic. This change provides the benefit of having all output files stored in a single workbook, making file modification easier. In addition, AHA partial-molar-volume vs. temperature data were measured in the laboratory and equations were added to the module that calculates aqueous density.
- [ANL] *UREX+ Laboratory-Scale Demonstration*. A spent fuel pin from the Big Rock Point Reactor (Michigan) will be dissolved in HNO_3 to provide the feed for the UREX+ process demonstration. The fuel beginning-of-life enrichment was 4.6% ^{235}U . The irradiation history of the pin was two-stage: (1) irradiated in a traditional commercial power cycle and (2) further irradiated three years after completion of the first irradiation. The ORIGEN2 code was run using parameters that closely model the fuel history. Based on these results, a simulant will be prepared to initially test the UREX+ process. A UREX+ demonstration with the dissolved fuel pin will follow.
- [ANL] *Actinide/lanthanide (An/Ln) separation—CYANEX 301 extraction*. A database of distribution-coefficient data for the CYANEX 301-based An/Ln separation process is being compiled. Published D-value data are being collected from a review of the technical literature. These data, along with laboratory data, will be used to develop a process model to be incorporated into AMUSE.
- [ORNL] *SANEX Studies*. The synthesis and purification of a nominal 25-g batch of the BTP extractant, 2,6-bis(5,6-di-ethyl-1,2,4-triazin-3-yl)-pyridine, was completed. This extractant will be tested in a similar manner to the dithiophosphinic acids.
- [ANL] *Laboratory-Scale UREX+ Hot Demonstration*. Work continues on the construction of the 24-stage 2-cm centrifugal contactor for the shielded-cell facility. Contactor prints were updated to improve the contactor design, adapt it for shielded-cell use, and reduce machining complexity. The new design was reviewed and approved. The use of a Nicrobraz 51 braze instead of welding was evaluated and will be used to reduce crevices within the unit.
- [ORNL] *Modified Direct Denitration Process Development*. The surrogate fission product nitrate solution preparation has progressed with the dissolution of the nitrate salts and a few oxide compounds. The dissolution of the molybdenum oxide proved to be more challenging, and more aggressive methods are being investigated. This solution will be used for testing with the modified direct denitration furnace and to generate a feed solution for further dissolution studies. The rotary furnace and the associated off-gas scrubbing system was installed in the glove box. Some minor modifications, mainly to the support structures for the pieces of equipment, were made to allow for easier operation and maintenance in the glove box. The equipment was tested after the glove box installation and can be used with surrogate solutions during

Separations continued

the review for operations with radioactive materials.

- **[ORNL] *Process Codes*.** Examination of flowsheet conditions for the planned UREX+ Solvent Extraction Hot Test continued using the AMUSE code, the SEPHIS code, technical references, and conversations with French experts. This work has led to two concerns. First, prediction of solvent-phase acidity in the extraction/scrubbing contactors was a factor of 10 higher when calculated by the AMUSE code than when calculated by the SEPHIS code. Previous experiments appear to validate predictions calculated by the SEPHIS code. Additional data on nitric-acid extraction at high uranium loadings are required. Second, the AMUSE code algorithm for technetium extraction does not account for pertechnetate extraction as a Zr-TcO_4 species. Although extraction of Zr is minor compared to the amount of U that is extracted in the UREX process (especially with the addition of AHA to the scrub), under some operating circumstances, based on technical reference data, the extraction behavior of technetium could be greatly enhanced by significant Zr extraction. If Zr were included in the Tc-extraction algorithm, it is possible that total extraction of Tc could be accomplished at higher temperatures, higher acidities, and with fewer extraction stages than predicted by AMUSE. The effects of reducing agents, such as HAN and U(IV) on technetium and neptunium stripping were clarified by the technical references.
- **[ORNL] *UREX+ Engineering-Scale Demonstration*.** Several meetings have been held to discuss the use of the TAN-607 facility for the hot phase of the Engineering Scale Demonstration (ESD). EM currently plans to deactivate this facility and surrounding related facilities starting in 2004. Several potential projects are investigating TAN-607 facility for application to their project. A draft report summarizing the issues, uses, maintenance requirements, and other factors has been started with plans for completion by May 30, 2003. It is anticipated a “business plan” will also be created to establish the baseline for an agreement between EM and NE for the facility.
- **[INEEL] *Engineering-Scale Demonstration Facility Feasibility Study*.** All feasibility study work with Washington Group International (WGI) is proceeding on schedule and cost. An over-the-shoulder review of the ESD feasibility study was held in Denver on March 13, 2003 to go through the design basis with WGI. The principal effort to date includes: (1) development of separations and solidification process flows; (2) development of process equipment sizing and equipment list; (3) development of operations/throughput basis/approach; (4) development of equipment and facility arrangement layout; (5) evaluation of fuel characterization and development of source terms; (6) fuel preparation study; and (7) addressing criticality control requirements. All space within the TAN Hot Shop, Warm Shop and Hot Cell (and possibly the pool area) will be required for the full demonstration. The WGI design includes about 180 pencil tanks to provide a 1-day surge capacity.
- **[INEEL] *Cs/Sr Extraction Process Development*.** Laboratory testing continued for development of a chlorinated cobalt dicarbollide (CDC)/polyethylene glycol (PEG) based solvent extraction process for the separation of Cs and Sr from dissolved LWR fuel. Several solvent compositions were evaluated by performing batch contacts with a simulated UREX raffinate solution. The results of the testing performed to date indicate that a CDC/PEG process should be very effective in separating Cs and Sr from dissolved LWR fuel. Further testing is planned in which distribution coefficients will be measured using feed simulant containing fresh

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AHA. This will allow the effects of AHA to be measured for the operating scenario in which the UREX raffinate is fed to the CDC/PEG Process with insufficient time for the AHA to decompose.

Pyrochemical Separations

- [ANL] *PYROX Process Development*. Preparations are underway for the second high-capacity reduction (HCR-2) test designed to evaluate the mass transfer characteristics and gas evolution efficiency of the electrolytic reduction cell. Fabrication of large (~50g) monolithic inert ceramic anodes is in progress. The performance of these anodes will be evaluated in each of the electrolytic reduction cell design options.

Engineered Product Storage

- [LANL] *Technetium Product Preparation for Storage/Transmutation*. A simulated technetium strip solution was prepared based on the technetium product stream from the UREX experiments at SRTC. The general approach for recovering technetium from this stream is to distill the acid, dissolve the residue with water, remove impurities, and then reduce technetium to the metal or technetium dioxide with BH_4^- or N_2H_4 , respectively. Distillation experiments have been performed with 50-mL acid solutions, with the following results:

Temp°C	% Acid Distilled	% Tc retained
166	97	90.7
145	95	94.9

Stopping the distillation at a larger residual volume, ~2-5 mL, may improve the technetium recovery but will increase the residual acid. Potential modifications to the distillation system are under consideration.

- [ANL] *Means for recovery of Technetium and Its Conversion to Metal*. A memo was prepared that provided two alternative process flowsheets for the production of technetium metal from the

Tc strip product for the UREX+ engineering-scale demonstration at INEEL. A detailed draft report with additional processing options for production of Tc metal is being prepared for release at the end of April.

Spent Fuel Treatment Facility Design

- [WSRC] Deployment Options activity team members traveled to INEEL for a 2-day meeting to review and edit the Spent Fuel Treatment Facility (SFTF) functions and requirements document. In addition, input was provided to the Scope of Work document for the SFTF pre-conceptual design. Feedback from activity team members on the deployment plan has been consolidated. A table of assumptions and an updated matrix (originated at the February team meeting) has been sent out for review and comment. A weekly conference call was initiated beginning on March 11 to discuss comments and to status action items. An effort is underway to generate a quality draft of the deployment plan by the end of May.
- [WSRC] A Reprocessing Facility Siting Selection Criteria document was drafted and issued for comment. This document was in response to discussion at the March 25th conference call regarding siting selection methodology. It is a "strawman" method to readily compare several scenarios versus a common set of siting criteria.
- [ORNL] *Deployment Options*. The approximate capital costs of reprocessing plants as a function of plant throughput is being examined. Data developed by US designs in the 1970s and 1980s serve as the primary documented bases. The usual scaling law that capital costs are proportional to the n th power of capacity (where n is a constant) is not valid over wide ranges of capacity, because the value of n also depends on plant capacity. Preliminary calculations indicate a broad minimum in unit installed cost between 2000 to 8000 MTIHM/yr. Additional work in

Separations continued

this area is continuing.

- **[INEEL] Spent Fuel Treatment Facility Design Support.** A draft of the High-Level Functions and Requirements (F&R's) for the Spent Fuel Treatment Facility were reviewed by members of the Functional and Operations Requirements Development activity team on February 26-27 at the INEEL. Comments from this group were incorporated and a second draft delivered to the group for review. A draft Statement of Work (SOW) for the A-E firm was also completed and includes studies for the A-E to look at both aqueous processing and pyrochemical processing alternatives. This SOW was also given to the Separations Working Group for review. The current contract with WGI allows for the SFTF preconceptual design to be added as a second phase of work.

Advanced Process Development

- **[LANL] Actinide Crystallization Process.** Preliminary process analysis and flowsheet design for the actinide crystallization process was completed, as was design of the bench-scale crystallization equipment for nitric acid solutions. A detailed material balance has been calculated for the continuous loop crystallizer, and the Piping and Instrumentation Diagram for the crystallizer has been revised and additional equipment ordered. The feed entry fitting has been designed for the loop crystallizer. The feed solution will boil, cool, and mix with the bulk solution in this entry region and the design of this entry fitting will have important impacts on the crystallization process.
- **[LANL] High-temperature Separations.** Two surrogate sample types have been produced. The first powder batch was prepared using 1.5 mole% ZrO_2 and 98.5 mole% TiO_2 . From this batch of powder, approximately ten rods were made and annealed. Of the ten rods, six made it successfully through zone melting. Two of the

six rods have been cut, ground, and polished for characterization. The second surrogate powder was prepared using 1.5 mole% Nd_2O_3 and 98.5 mole% TiO_2 . From this batch of powder, approximately four rods were made and annealed. Of the four rods, one made it successfully through zone melting. It will also be prepared for characterization. A literature review of phase relations in the surrogate systems SrO-ZrO , $\text{Cs}_2\text{O-ZrO}$, and $\text{Nd}_2\text{O}_3\text{-ZrO}$ was completed. There is currently no published literature on the $\text{Cs}_2\text{O-ZrO}$ system. Phase diagram calculations of these systems have started.

- **[ORNL] Voloxidation Process Development.** As part of a collaborative effort with ANL-W, a draft version of the proposed outline for the development of an advanced "Voloxidation Process" for the dry, head-end removal of volatile fission and activation products is being prepared.

EBR-II Spent Fuel Treatment

- **[ANL] Support to the UREX+ Engineering-Scale Demonstration.** Representatives from the EBR-II Spent Fuel Treatment activities at ANL participated in the Separations Working Group Meeting at the Savannah River Site. At this meeting discussions were held to determine if support from Spent Fuel Treatment Operations at ANL could be used to support the planned engineering-scale demonstration of the UREX+ process technology at the INEEL. A number of potential areas for support were identified and will be incorporated into the work packages for EBR-II Spent Fuel Treatment.
- **[ANL] EBR-II Spent Fuel Processing.** Forty-eight kilograms of heavy metal from EBR-II blanket elements were processed in the Mark-V electrorefiner during the month of March. Processing the blanket material serves to increase the plutonium content in the salt, in support of transuranic recovery tests. A total of

Separations continued

191 kilograms of driver fuel and blankets has been treated in FY03.

- **[ANL]** *Recovery of Transuranic (TRU) Elements from Spent Fuel.* Design activities were completed on equipment to support Liquid Cadmium Cathode (LCC) reactivation and continued on equipment to allow transuranic product recycle. A qualification test procedure for the LCC handling equipment was approved and a test procedure for operation and maintenance of the LCC itself was drafted and submitted for review. A preliminary design has been completed for the anode basket to return material from the transuranic recovery experiments to the Mark-V electrorefiner. After characterization, the recovered transuranics are to be recycled back to the electrorefiner to support additional tests.
- **[ANL]** *U/TRU Electrolysis.* The design of the lab-scale U/TRU electrolysis cell (EC1) for development testing was essentially completed and fabrication of the components is underway. Preparation of the laboratory glovebox, the fabrication of EC1 components, and the establishment of a chlorine gas scrubber are progressing on schedule. Equipment assembly and shakedown testing is expected to begin soon.
- **[ANL]** *Hot Demonstration of the PYROX Process.* Installation of an additional power supply and associated instrumentation to support PYROX testing in the Hot Fuel Dissolution Apparatus (HFDA) in the Hot Fuel Examination Facility is underway. Procedures to install and operate the HFDA modifications for the PYROX demonstration are complete. Unirradiated oxide fuel elements have been declad, crushed, and sieved to qualify the HFDA modifications for PYROX operations, prior to process demonstration with spent LWR fuel.

For more information on Separations contact Jim Laidler (630) 252-4383

Fuels

Integration

- [NTD] The fuel development NTD attended the following meetings in Paris/France: OECD/NEA Working Party on Partitioning and Transmutation (March 12 – 14, 2003), and MEGAPIE Technical Review (March 18 – 19, 2003). (*See Transmutation Engineering section for details*)
- [NTD] The meeting minutes for the 2nd FDWG meeting was published and distributed to all the participants.
- [NTD] Based on the reduced AFCI budget numbers, FY03 re-planning efforts on the fuels schedule and milestones have started.
- [NTD] We have established a weekly tele-conference among the project participants. The tele-conferences will be every Thursday from 4 pm to 5 pm (EST). The call-in number is distributed to all the fuel team's members.

Series One Fuels Design, Specifications and Analyses

- [WSRC] A white paper, the "Evaluation of Initial Market for MOX from Recycled Commercial Spent Nuclear Fuel", has been drafted and distributed for internal review to the deployment committee of the Fuels Development Working Group. The paper reviews the use of MOX in the suggested baseline class of commercial reactors; it then discusses the amounts of plutonium required, challenges to the program and recommendations.
- [WSRC] We participated in the Separations Working Group meeting and made a presentation on initial market scenarios for MOX in commercial reactors and the respective plutonium needs from a separations facility.
- [ORNL] Series-1 activities were severely curtailed during March as a result of continued budget uncertainties. These uncertainties prevented finaliza-

tion of the associated work package. At the end of March, a funding allocation was determined by ORNL management in conjunction with the National Technical Directors and DOE/NE. Work package modifications based on that allocation will be performed early in April.

- [ORNL] Based on the funding allocation, procurement of TRANSURANUS will be deferred to FY04, pending availability of FY04 funds.
- [ORNL] Work continued to develop schedule and cost estimates for a fast-track commercial implementation of Series-1 MOX. This effort is being coordinated with and may be rolled into the ongoing Implementation work conducted by Steve Sheets (WSRC).

Series One Fuel Development & Fabrication

- [LANL] The model of defect chemistry and oxygen diffusion in $\text{CeO}(2-x)$ was completed and a journal article is in writing. The model will be further extended to the $\text{UO}(2+x)$ and $\text{PuO}(2-x)$ compounds.
- [LANL] A computer code for binary phase diagram simulations was integrated in a MathConnex project and is ready to be used for the calculation of phase diagrams in actinide based oxides and nitrides.
- [LANL] A dri-train has been procured and installed for a second double workstation glove box located at MST. This system will allow measurement and control of oxygen and moisture levels and an increase in the process development/optimization capability for Series One fuels.

Series One ATR Irradiation Experiments

- Because of uncertainties in INEEL budget, no activities were initiated in March. This work will begin in April.

Fuels continued

Series Two Fuel Design Specification and Analyses

- [ANL] For the low-conversion ratio fast reactor analysis, a more rigorous treatment was employed for group constant generation in the axial reflector region. With the refined cross sections, diffusion theory void worth results are much more accurate when compared to Monte Carlo solutions for the pancaked (high leakage) and compact configurations. Diffusion theory appears to be adequate for the CR=0.25-0.50 range, with some underprediction of void worth (less than \$1) at very high leakage (CR=0).
- [ANL] The FY02 simplified safety analysis model was modified to accommodate the compact core configuration. The increased core height required changes in the above core and control rod drive line modeling; balance of plant model was retained.
- [ANL] Loss-of-flow, transient-overpower, and loss-of-heat-sink transients were evaluated for the four compact fast reactor configurations with conversion ratio ranging from 0.5 to 0. Qualitatively, the results are similar to the FY02 (pancaked core) transient behavior. However, the margins to coolant boiling and fuel melting are significantly smaller; increases in the fuel and coolant temperature of 50-135K were observed compared to the FY02 results.

Series Two Nitride Fuel Development

- [LANL] A solid solution of Pu oxide and Zr oxide was formed. This was used as a feed for carbothermic reduction.
 - [LANL] The oxide that was solutionized in 1 above was converted to nitride. The predicted and measured weight loss for full oxide-to-nitride conversion were very close to each other. X-ray diffraction is currently underway to determine the degree of solution for both the oxide and nitride.
 - [LANL] Nitride pellets were fabricated in which the sintered density was higher than the cold pressed density (unlike when pure PuN was reacted with pure ZrN). None of pellets demonstrated end-capping along any of the process steps (cold press, sintering), even when subjected to a moderate axial stress after sintering. The pellets met the density and dimensional specifications.
 - [LANL] Nano-indentation hardness and modulus measurements continue to be performed on heavy ion irradiated ZrN to provide an indication of the changes of these extrinsic and intrinsic properties. Hardness of ZrN continues to increase with implantation of up to 2×10^{16} Xe @ 450 keV (80 dpa peak) while the modulus is substantially unchanged within the error of the measurement. The hardness was measured to increase up to 20% relative to unirradiated ZrN.
 - [LANL] In the effort to minimize Am volatilization during fuel processing, the nitride pressing parameters continue to be optimized and the sintering aid study has been restarted. The mill/cold-press/sinter process has been improved for ZrN processing enabling a >5% increase in green and corresponding sintered densities. This process enhancement must still be transferred to TA-55 and verified for the (TRU)N-ZrN fuels.
 - [ASU, LANL] The role of preferred crystallographic orientation of grains (texture) with respect to anisotropy of mechanical properties in the mono-nitride fuel materials continues to be examined. Previously, significant texture was measured in sintered ZrN pellets. Further measurements of fracture toughness anisotropy have revealed variations from sample to sample; however, a qualitative trend is present. Measurement of texture on green ZrN pellets has been carried out and data are being analyzed for comparison with the sintered pellet texture data.
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Fuels continued

- [IC, LANL] Long term QM calculations of UN/ZrN solid solutions have been the exclusive focus throughout this period. A series of different UN/ZrN compositions (stoichiometries) have been simulated and current results show that structure volumes and energies do not follow a simple rule of mixtures (none ideal behavior). It is not yet clear if this is a consequence of the limitations of the calculations or indicative of behavior in this system.

Series Two Metallic Fuel Development

- [ANL] The deliverable “Final report on microstructure analysis and phase equilibria of as-cast AFC1(b,d) samples” was completed and submitted to the AFCI program.
- [ANL] Two fuel-cladding chemical interaction (FCCI) diffusion couple samples (MA: Pu-60Zr, MB: Pu-10Np-40Zr) were heated at 650°C for 50 hours against 422 stainless steel. These were cut, ground and polished for SEM study. The SEM study was completed and showed very little diffusion had occurred, on the order of a 10-20 micron maximum diffusion of iron/chromium (Fe/Cr) into the fuel. Other observations included fuel microstructure appearing consistent with phase diagram for 650°C annealing temperature. There is no evidence for melting in either sample.
- [ANL] Two exploratory fuel-cladding chemical interaction (FCCI) diffusion couple samples (MB: Pu-10Np-40Zr, MC: Pu-12Am-40Zr) were heated at 850°C for 100 hours against 422 stainless steel. This temperature is far above the expected cladding operating temperature of ~550°C. These were cut, ground and polished for SEM study. The SEM study was completed and showed complete diffusion of Fe/Cr deposits throughout the fuel. No evidence of melting was observed.
- [ANL] It was discovered that the two ternary Pu-10Np-40Zr samples used in the FCCI experiments contained significant amounts of copper (from

fusion with the arc-melter hearth). This was the same casting from which the TMA (thermal mechanical analysis) sample that appeared to show signs of melting during thermal cycling up to 925°C was taken. The final physical appearance of this TMA sample was very much different than any other TMA sample studied (including another smaller ternary Pu-10Np-40Zr sample) and preliminary indications are that melting is attributable to the presence of high levels of copper contamination in the sample. As a result, the melting behavior of the ternary Pu-10Np-40Zr alloy is being reconsidered. Another more representative sample of the Pu-10Np-40Zr fuel (MB) was thus prepared for TMA study.

- [ANL] The Analytical Lab DTA/DSC/TGA instrument was repaired in March and will be tested and used to acquire more thermal analysis data on AFC1(b,d) samples in April.
- [ANL] Two presentations on AFC1(b,d) metal fuel microstructural and thermal characterization were given at the TMS Annual meeting in March.

Series Two TRISO Fuel Development

- **Issue:** Because of FY03 budget constraints, the portion of the TRISO fuel development work performed under AFCI will be delayed until FY04. This section will no longer be included in the monthly reports.

Series Two Advanced Fuel Forms

- *Information provided contained Patent Sensitive Information: If you would like to have information on progress in this area, please contact Kemal Pasamehmetoglu.*

Fuels continued

Series Two ATR Irradiation

- **[INEEL]** The drawing for the Advanced Test Reactor Critical (ATRC) facility basket was approved and released.
- **[INEEL]** The ATRC facility mockup test has been scheduled for April 7, 2003. Measurements will support the Core Safety Assurance Package and the Experiment Safety Assurance Package. Necessary documentation to perform the ATRC test have been prepared and submitted.
- **[INEEL]** The contract for ANL-W to fabricate the ATRC baskets was prepared and approved. Prior to release of the contract, an ANL-W Quality Assurance Program inspection was required in order to certify ANL-W as a supplier. A review of ANL-W Quality Assurance Program was performed and approved by the INEEL. ANL-W will be classified as an approved supplier and placed on INEEL's approved supplier list. The contract will be released the first week of April.
- **[INEEL]** A drawing for the AFC-1 experiment storage grid in the ATR canal has been completed and approved. Fabrication will begin in early April.
- **[INEEL]** Approval of the Environmental Checklist for the AFC-1 EFT baskets was received. An approved waste stream for the un-irradiated and irradiated cadmium baskets has been identified.
- **[INEEL]** Drilling of the borated aluminum rods has been canceled due to the inability to weld the borated aluminum / aluminum joints. The rods will be shipped back to the INEEL.
- **[INEEL]** Temperature reactivity coefficient analyses for variants on the AFCI experiment assembly were performed. Analyses were also completed to predict the reactivity change associated with insertion of the AFC-1 experiments. Results indicate that the four-train AFC-1 assembly is comparable in reactivity to a six-pin LSA cobalt assembly. Thus, LSA cobalt will be used as a backup test if needed.
- **[INEEL]** Thermal and physics analyses performed on the cadmium shrouding are approximately 95% complete.
- **[INEEL]** Stress analysis to support the Experiment Safety Assurance Package (ESAP) has been completed and is currently in review.
- **[INEEL]** The ESAP is currently in review by project personnel and will be sent out for TRA review and approval in mid April.
- **[INEEL]** A single shipment of all six test assemblies is currently planned. The assemblies will be loaded in the ATR Canal and sent directly to ANL-W using the GE-2000 cask. Handling of the GE-2000 cask is a new capability for ANL-W, and is not expected to be in place until the spring of 2004.
- **[ANL]** Nitride fuel pellets supplied by LANL were encapsulated into HT-9 clad rodlets. On opening the welded steel shipping containers, several pellets were found to be broken with features of the break characteristic of end-capping defects introduced during pellet fabrication. After consultation with R. Margevicius and K. McClellan (LANL) these pellets were replaced with archive material where possible. Top end plugs were welded on to the rodlets. During end plug weld radiography at the FMF (Fuel Manufacturing Facility) on 26-Mar-03, it was noted that fuel debris was visible in several rodlet radiographs. Because these radiographs were focused on only the top rodlet weld, not all of the pellets are visible on the exposure; however, more than one-half of the pellets visible on

Fuels continued

the radiographs were broken, chipped, cracked, or contained end-cap defects. Interviews with the supervisors overseeing the work and technicians performing the loading and radiography were performed. The supervisors and technicians indicate that pellets were never forced into cladding tubes during loading, that loaded rodlets were handled gently, rodlets were not inverted, and no rodlets were dropped.

- **[ANL]** Additional follow up radiographic examination was performed focusing on the fuel pellets. Due to the high gamma field from the fuels with high Am content, radiographic details on all of the pellets are not visible due to over-exposure. Of the 71 pellets that are visible, 51 contain defects as described above. Additional attempts will be made at radiography of the high Am pellets. A report is being assembled describing the types and location of all defects.
- **[ANL]** The Draft Experiment Description for the AFC-1E and AFC-1F capsules was completed and distributed by the deliverable milestone of March 28, 2003. The experiment description incorporated the results of the initial physics calculations.
- **[ANL]** Fabrication of the eight cadmium baskets required for ATRC (ATR critical facility) testing was completed and receipt inspection by the INEEL is scheduled to take place at ANL-W on April 2. INEEL will transport the baskets to the Test Reactor Area for use in the ATRC experiments scheduled for the week of April 7.
- **[ANL]** We completed its evaluation of post-irradiation examination, storage and disposition of the irradiated cadmium baskets that will be generated as part of the AFC-1 series of irradiation in the ATR. The baskets will be stored at ANL-W's Radioactive Scrap and Waste Facility until treatment of them can be performed at ANL-W's Radioactive Treatment Facility. The

treated waste will be shipped to Envirocare for disposal.

- **[ANL, INEEL, LANL]** A meeting was held at INEEL on March 20, 2003 to discuss the AFC-1E low-fertile, nitride fuel compositions. S. Hayes and B. Hilton (ANL), R. Margevicius and M. James (LANL), R. Ambrosek, G. Chang, D. Utterbeck (INEEL) were in attendance.
- **[ANL]** Initial physics calculations were performed for the AFC-1E and AFC-1F fuel compositions. The AFC-1E nitride fuel experimental rodlets will have the same enrichment in all fuel compositions to facilitate the nitride pellet fabrication schedule. The AFC-1F metal fuel experiment will have varying enrichments in the different metallic fuel compositions so that all rodlets achieve similar peak linear powers.
- **[ANL]** Review of the LANL Quality Assurance Program for the AFC-1A-1D ATR experiment was completed. This evaluation will allow insertion of AFC-1A and AFC-1C nitride fuels to be encapsulated and inserted in the ATR.

Series Two FUTURIX Irradiation

- **[ANL]** Final input to the FUTURIX-FTA Presentation Report was provided to CEA for the nitride and metallic fuels to be included in the FUTURIX fuels test in the Phénix reactor.
- **[ANL]** The document, "Fuel Research and Development Plan for Metal Fuel to be irradiated in the FUTURIX-FTA Experiment in Phénix," (W7520-0524-ES-00, 14-Mar-03) was submitted to the AFC program and to CEA for review.

Fuels continued

ATR Fast Flux Booster Design

- Issue: [INEEL] Because of FY03 budget constraints, Fast Flux Booster design work will be delayed until FY04. This section will no longer be included in the monthly reports.

Looking Ahead

- All FY03 fuel work-packages will be completed and submitted to the technical integration team (SNL) by April 18, 2003.
- The NTD will attend the program plan development meeting in Washington D.C. on April 8 and 9, 2003 with other NTDs and the DOE managers.
- Mitch Meyer (ANL), Steve Hayes (ANL), Ken Chidester (LANL) and Bob Margevicius (LANL) will travel to Cadarache, FRANCE to attend the FUTURIX QA workshop on April 28 and 29, 2003.
- A contract from INEEL to ANL-W for fabrication of cadmium baskets for AFC-1A -1D experiment insertion in ATR should be in place as early as possible in April in order to allow adequate time for inspection and testing of the baskets.

For more information on Fuels contact Kemal Pasamehmetoglu: (505)667-8893

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INTEGRATION [LANL]

- Developed a plan to use some of PNNL funding to catalog material samples irradiated in FFTF that were about to be discarded as waste. Most samples will be shipped to other labs for examination.
- Participated in integration meetings held at INEEL and Idaho State University.
- Work packages were revised and developed for the final funding numbers. Milestones and scope were revised to reflect a reduced budget.

PHYSICS

Cross-Sections

- [ANL] The analysis of the PROFIL-2 experimental data with JEF2.2, ENDF/B.V and ENDF/B.VI, was completed and the report, *Analysis of PROFIL Irradiation Experiments for Cross Section Validation* was written, satisfying an AFCI Level-3 milestone on schedule.
- [LANL] Submitted a proposal for beamtime at LANSCE to measure the Np-237 capture cross section using “DANCE” (an instrument at the Neutron Scattering Center for measuring neutron capture cross sections).
- Researchers at KRI (Khlopin Radium Institute, Russia) claim to be able to make pure metal foil samples of minor actinide material. If confirmed, we will consider ordering samples from them.
- [LANL] Improving the Am-241 ENDF evaluation to provide better AFCI calculations of criticality and transmutation using new recently-published measurements. The (n,2n) cross-section evaluation data in the existing ENDF file was made before any experimental data existed.
- We made significant progress re-evaluating the fission cross section of Np-237. Reduction of the Lisowski fission data was finalized, and the new cross sections are consistent with our

evaluation. We have incorporated these changes into an ENDF file and have performed integral data testing in LANL fast-critical assemblies, showing experiment and theory agreement to within 2-3%.

- [LANL] A report on neutron-production of hydrogen and helium was completed (*Neutron-Induced Hydrogen and Helium Production from Threshold to 100 MeV*), satisfying an AFCI Level-3 Milestone. The paper has been submitted to the ANS conference to be held in San Diego in June.
- [LANL] We are exploring an in-house capability to fabricate chromium samples following the loss of a prospective supplier; the first electro-deposition has begun.

Codes (Fuel Cycle Method Code Development) Development

- [LANL] Completed integration of the INCL (“Cugnon”) physics model into MCNPX25c (a major, multi-month undertaking), satisfying an AFCI Level-3 Milestone. We now have five major physics model packages available—Bertini, Isabel, Fluka, CEM2k and INCL. The INCLUDE model will be available on a limited basis pending approval by our French collaborators.
- [LANL] In the model region of MCNPX, we enabled the mesh-based weight-window generator and the exponential transform for neutral particles, satisfying an AFCI Level-4 milestone.
- We corrected secondary particle biasing in the MCNPX code, and modified and integrated the McKinney-allocate patch to correct F90 problems on some systems.

Publications

- [LANL] Significantly upgraded the Mix-and-

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Match Report to reflect improved calculational results, and made final publication of the report *MCNPX Model/Table Comparison*.

Fuel Cycle Method

- [LANL] The MC2-2 code has been updated so that the in-group P1 scattering matrix written in an ISOTXS format can be modified to take into account the correction needed for its use in transport whole-core calculation codes.
- [ANL] For the treatment of transport in low-density regions of materials, a prototypic coupling coefficient code has been written to test first-order spherical-harmonics formulation. Preliminary analysis shows the method produces stable and accurate vacuum-node response matrices for P9 and higher order angular approximations.

MALIBU

- [ORNL] Although funding was significantly cut, we can participate minimally in the MALIBU program during FY03. ORNL will attend the MALIBU Program Committee Meeting in June, start analysis and modeling, and begin contract negotiations. Payment to Belgonucleaire will be deferred to FY04 and FY05; the Work Package has been modified to reflect this change.

STRUCTURAL MATERIALS

Materials Testing

- [LANL] Final preparations were performed on ferritic-martensitic and austenitic stainless steel specimens that will be inserted in the DELTA loop for corrosion tests.

Hot-Cell Activities

- [LANL] Bend tests were performed on irradiated SS-316L and Mod 9Cr-1Mo at room temperature. Specimens were irradiated in rod form at PSI at 350°C.

- [LANL] Gamma measurements were performed on TEM disks of SS-316L and Mod9Cr-1Mo to determine if positron measurements can be made at the Idaho Accelerator Center.
- [PNNL] Completed the evaluation of the shear-punch materials-test fixture and sent it to LANL.

Materials Handbook

- [LANL] A second draft of the Tantalum chapter of the Materials Handbook was prepared and will be issued shortly for general review.
- [LANL] Work continued on the HT-9 stainless steel chapter of the Handbook. Second drafts of sections on material biography, chemistry, specifications, physical properties, and elastic properties were completed.

Radiation Damage Modeling

- Nothing to report

COOLANT TECHNOLOGY

DELTA loop

- [LANL] The DELTA loop was operated up to 450°C for over 60 hours during March, including unattended overnight runs. It was operated with newly-installed oxygen sensors with Graph-lock gaskets, providing data consistent with theoretical predictions.
- [LANL] Oxygen-sensor gasket tests continued in March, resulting in the decision to use Graph-lock gaskets (tantalum metal gaskets were made and tested also). Other forms of gaskets are still being investigated, and a more advanced redesign of the sensor is still underway.
- [LANL] The cleaning gas system was used several times, injecting cleaning gases for about 10 hours total; however, it did become necessary to manually remove oxides from the lead-bismuth to accelerate the cleaning process. An HCP and procedure for manual removal of

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oxides was prepared.

LBE Technology and Corrosion

- [LANL] A new LBE-technology work package was prepared to assist in Gen IV efforts, including an upgrade to the DELTA loop with a bypass extension, and a liquid-metal direct-contact pyrolysis of methane procedure to form hydrogen.
- [LANL] Redesign of the oxygen sensor calibration stand has been nearly completed, and a new chemistry lab is being set up for an experiment to study hydrogen pyrolysis.
- [LANL] Two corrosion-modeling papers were accepted for publication in archival journals (*J. Nuclear Materials, Nuclear Technology*).
- [LANL] Modeling of oxidation kinetics was initiated in collaboration with MIT.
- [LANL] The contract extension between UNLV and the ISTC (International Science and Technology Centre, Moscow) for the ISTC LBE Target Complex now installed at UNLV was approved, and a new Statement of Work finalized.

ACCELERATOR-DRIVEN SYSTEMS

MUSE

- [ANL] Investigation of reflector effects of configurations similar to the MUSE experimental setting continued using macrocell calculations for the cross section generation. Results indicate a large improvement compared to standard methodology.
- [ANL] A first draft of a paper for NSE (Nuclear Science and Engineering) summarizing the early MUSE experiments, including static and dynamic measurements in the reference cores and SC0 configurations, was prepared by the part-

ners participating in the MUSE experimental program.

MEGAPIE

- [LANL] Participated in the MEGAPIE Technical Review held in Paris, and presented DOE design concerns on target development. Detailed meeting minutes were submitted to DOE.
- [LANL] Review of target drawings and documentation in advance of “Readiness For Manufacturing” was a major focus of activity.
- [LANL] Additional DOE contributions to the MEGAPIE Project included continued work on reliability (focusing on the window, pump and heat exchanger), and flange analysis of the upper part of the guide tube (a unique, custom part where different materials and components are joined).

TRADE

- [LANL] A paper entitled “The TRADE Target Design and Development” was completed and submitted for presentation at the ANS AccApp’03 Conference to be held in June.
- [ANL] Our neutronics calculations were presented by our ENEA colleagues (Frascati, Italy) at a TRADE coordination meeting held in Paris. Forced convection was selected as the preferred option for cooling the target.
- [ANL] Analysis continued of the TRIGA reactor core to be used for the TRADE experimental program using the DIF3D and MCNP codes in hexagonal geometry. DRAGON cross sections were used and reaction rate distributions using the VARIANT code were generated.

International Collaborations

- [LANL] For the OECD/WPPT (Organization For Economic Co-Operation And Development /

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Working Party on Partitioning and Transmutation), LANL staff drafted the Introduction, and the Functions and Requirements chapters for the state-of-the-art report on Accelerator Utilization and Reliability for Transmutation. LANL staff also developed an outline for the accelerator sections of the report.

- [LANL] Staff attended the Accelerator Utilization and Reliability subgroup (AURS) and WPPT meetings in Paris, where writing assignments for the above-mentioned report were made, and where working-group charters for LBE Technology and Accelerator Reliability were completed and memberships established.

UNIVERSITY PROGRAMS

University of Michigan

- T-91 and HT-9 samples were prepared (machined and polished) for a second irradiation.
- For PWR transmutation studies, cross-validation of the WIMS-ANL code against the CASMO-3 code got underway in consultation with ANL staff. WIMS-ANL offers a new cross section library with a fine-group structure for higher actinides.
- A physical interpretation of differences in the space-time behavior of the reactivity measured in different regions of a subcritical system has been obtained.

University of California Berkeley

- UCB continued efforts on the design of a reference finite-dimension molten-salt transmuting reactor.
- UCB developed an MCNP model for a full pebble for the analysis of pebble-bed transmuting reactors. We are now testing the ability of MOCUP to perform depletion analysis for thousands of fuel kernels in a pebble.

- We applied our simplified fuel-cycle analysis model to quantify the effect of the uncertainty in the Am-241-to-Am-242 branching ratio on the evolution of actinide concentration in a LBE-cooled transmuter.

North Carolina State University (NCSU)

- As part of the SINQ Target Irradiation Program (STIP III), MCNPX calculations were performed for transmutation-product yields in materials currently undergoing irradiation in SINQ Target 5 to assess the possible influence of transmutation products as impurities.

University of Texas-Austin

- Visual coding using Visual Basic and the MS Visio software to create a user-friendly application for evaluating fuel cycles for proliferation-resistance assessments continued.
- Results for fuel-transmutation rates, fuel and structural-material isotopic compositions, decay heat, and radiation-damage rates to structural materials were generated using a full-core ADS simulation with MCNPX linked to ORIGEN.

University of Illinois

- University staff performed detailed design of cooling, gas, and thermal systems for the LBE-corrosion system, acquired the main components of the cooling and gas systems, acquired data-acquisition and instrument-control hardware and software for corrosion monitoring and control, and acquired impedance-spectroscopy hardware.

University of Florida

- Arrangements were made with U of Michigan to irradiate oxidized HT-9 samples in relatively prototypical conditions for electron microscopy and other analyses at Florida.
 - Baseline thermogravimetric analysis, oxidation studies, and hydrothermal oxidation studies of HT-9 were begun.
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LANL University Programs Leader

- The LANL University Programs (UP) Leader is preparing and coordinating the planning for an international meeting on accelerator-driven systems to be held at UNLV for LANL-supported universities and others.
- The LANL UP Leader continued to initiate University contracts and contract extensions, and oversee technical work at LANL-supported universities.

***For more information on Transmutation contact:
Mike Cappiello (505) 665-6408***

University of Nevada LV

UNLV Transmutation Research Program (TRP)

Administration

- UNLV TRP reviewed and approved new scope of work to prolong the ISTC contract with IPPE to develop and conduct research on the ISTC Target Complex (TC)-1 located at UNLV.
- UNLV TRP reviewed and approved the architectural and engineering plans for remodeling Room TBE B-129 for housing the ISTC TC-1. Construction went out for bid, no schedule yet provided by UNLV Construction and Planning Office.
- UNLV TRP conducted administrative review of research tasks 1-4, and 13-14 and evaluation of proposals to renew these tasks for the next program year assuming level funding.

Issues

- UNLV needs DOE to provide Notice of Financial Assistance Award for FY03 funding such that accounts can be set up by May 1, 2003. Giving at least 10 days to set up accounts means that the award documentation should arrive at UNLV no later than April 17, 2003.

UNLV TRP Student Research

UNLV TRP Fuels

- Progress continues on the analysis of casting and solidification of the melt into molds. (Task 1)
- Modeling results for constant pressure casting, which is more realistic, have been obtained and produce physically realistic results for flow that starts, flows, and then eventually stops as it enters the mold. (Task 1)
- Potential mass transfer modeling features (Lammuir's law for example) are being studied to enhance the capabilities of a mass transfer in a detailed system model. (Task 1)
- Different parameters are being varied as part of

a parametric study to evaluate factors that impact the flow of the melt into the molds. (Task 1)

- The ability to include the induction heating governing equations as part of an overall system model is being studied and preliminary efforts to include this complex phenomenon as part of a more detailed model are underway. (Task 1)
- Development continues on a 3-D process simulation model with a Waelischmiller hot cell robot. (Task 9)
- Continuing work on concepts and methods for vision-based hot cell supervision and control. (Task 9)

UNLV TRP Separations

- A successful meeting was held March 6th and 7th with Argonne National Laboratory (ANL) researchers to discuss project details and good feedback and support was given for the project. (Task 8)
- Five specific objects are being implemented for the graphical user interface as a result of the meetings with ANL researchers: Flow sheet, Section, Streams, Stages and Concentrations. (Task 8)
- Work continues on the development of flow sheet objects that allows the user to select flow sheet name, reports location, type of process and other required input. (Task 8)
- A Separations area called "Tools" is being developed to allow the user to develop process blocks within the software environment to build a specific process flow sheet, which includes the ability to generate process streams, sections, stages and input data for each of them. (Task 8)
- Development of an overall process model contin-

ues using MATLAB with SIMULINK that will eventually allow the top five most influential factors to the process to be automatically selected those factors will be used for the design variables for the optimization. (Task 8)

- Completion of plutonium and americium mixture criticality and heat transfer analysis. (Task 11)
- Research begun on criteria for use of commercial dry casks for the storage of strontium and cesium. (Task 11)
- The ion chromatography method for separation of various iodine species was tested with NOM samples. Serious interference was discovered and a new column ordered. (Task 15)
- The transfer of iodide to organic matter as facilitated by the by the chlorine sulfonamide resins was examined. Using NOM analogs iodine was shown to become associated with organic matter in the presence of the active chlorine resins. (Task 15)
- Assembly continued on an apparatus for simulating nuclear fuel dissolution. (Task 15)
- Baseline Raman spectra have been obtained for hydroxyapatite and fluorapatite. (Task 16)
- Natural fluorapatite crystals have been obtained commercially, and will be examined spectroscopically to determine what contaminants naturally occur. (Task 16)
- Plans were developed for chemically preparing samples in which some of the calcium in apatite materials is substituted by nonradioactive actinide surrogates or elements produced by decay of actinides. (Task 16)

Issues

- Availability of UNLV Task 11 Principal Investigator to assist in research (due to promotion to associate dean) causing delays/communication problems.
- Task 15 is awaiting fullerene-containing carbon compounds from Khlopin Radium Institute collaborators.

UNLV TRP Transmutation Sciences

- Modified niobium cavity optimization code and created a random seed cavity generator. (Task 2)
- Two new optimized geometries based on resonant frequency and mode found. (Task 2)
- Tuning camera for fluid flow studies. (Task 2)
- Completed characterization of steel samples of HT9 using XPS. (Task 3)
- Enlarged the bibliography of LBE-related and associated publications. (Task 3)
- Stress corrosion cracking (SCC) tests using constant-load and slow-strain-rate (SSR) techniques are ongoing in aqueous solutions at ambient and elevated temperatures. (Task 4)
- Smooth and notched tensile specimens of Alloys EP-823, HT-9 and 422 are being used for SCC testing. (Task 4)
- SCC tests under controlled cathodic potentials (with respect to the corrosion potential) are ongoing to evaluate the effect of hydrogen charging on cracking. (Task 4)
- Localized corrosion (pitting and crevice) behavior of all three alloys is being evaluated by cyclic potentiodynamic polarization (CPP) method. (Task 4)
- Metallographic evaluations by optical micros-

copy are ongoing. (Task 4)

- Fractographic evaluations by scanning electron microscopy are in progress. (Task 4)
- Computer simulation results for Task 5 have been obtained for several geometries, i.e., 2-D sudden expansion flow, torroidal loop with momentum source simulation, straight pipe flow simulation. Wall temperature and concentrations were prescribed. Objectives are to estimate concentration wall mass flux to predict the areas on the wall which depict corrosion rates and those that predict precipitation rates; and, to locate maxima for each corrosion sites and precipitation sites.
- Completed the dose coefficients calculations for the QA radionuclides. (Task 7)
- Compared and contrasted results of DCs from different institutions. (Task 7)
- Implemented the new EDISTR computer code. (Task 7)
- High-temperature tensile testing using new specimen grips has been initiated. (Task 10)
- The ambient temperature tensile testing of Alloy EP-823 is ongoing, as planned. (Task 10)
- Additional tensile specimens of Alloy EP-823 are being machined from the heat-treated bars. (Task 10)
- Most of the parts for the Task 13 apparatus have been received and moved into TBE B310.
- After a few simulations, it was recognized that FEMLAB is not suitable for the simulation of the oxygen concentration and dissolving rate in LBE. (Task 13)
- LabView module for the control of our apparatus has been designed and is under testing and improvement. (Task 13)
- Cold-worked, bent and welded specimens of heat-treated Alloy EP-823 and Type 304L stainless steel are being evaluated for residual stress measurements. (Task 14)
- All three types of specimens are being evaluated for residual stress measurements by positron annihilation spectroscopy at the Idaho State University (ISU). (Task 14)
- Residual stress measurements in bent and welded specimens are in progress at the Lambda Research Laboratory (LRL) using X-ray and Ring-Core methods. (Task 14)

Issues

- Ion gun at XPS needs work, now working at 25% efficiency. Sample analysis taking longer than expected. (Task 3)

***For more information on Transmutation contact:
Tony Hechanova at 9702) 895-1457.***

University Research Alliance - Fellowship Program

University Programs

- All 2002 fellows have submitted their Final Research Plans and a timeline for completing their master's degree programs.
 - Thomas Carter - Feasibility of Mixed Carbide Fuel for Use in Transmutation Systems, Projected Grad Date - 12/03
 - Lisa Cordova - An Investigation of the